
GENERAL NOTICES

NOTICE 270 OF 2015

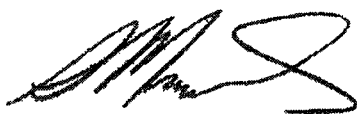


INDEPENDENT COMMUNICATIONS AUTHORITY OF SOUTH AFRICA

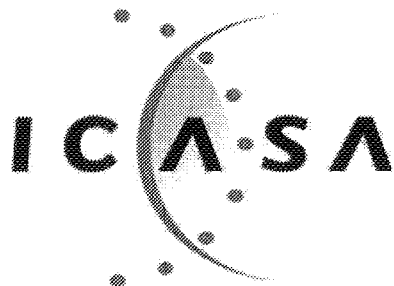
**PURSUANT TO SECTION 4 (1) OF THE ELECTRONIC COMMUNICATIONS ACT
2005, (ACT NO. 36 OF 2005)**

**HEREBY ISSUES A NOTICE REGARDING THE FINAL RADIO FREQUENCY
SPECTRUM ASSIGNMENT PLAN FOR THE FREQUENCY BAND 450 TO 470
MHz.**

1. The Independent Communications Authority of South Africa ("the Authority"), hereby publishes **Final Radio Frequency Spectrum Assignment Plan for the frequency band 450 to 470 MHz** terms of sections 2 (d), (e) and 4, read with sections 30, 31(4), and 33 of the Electronic Communications Act (Act No. 36 of 2005) and read with Regulation 3 of the Radio Frequency Spectrum Regulations 2011 and read with the IMT Roadmap 2014.
2. This Radio Frequency Spectrum Assignment Plan (RFSAP) supersedes any previous spectrum assignment arrangements for the same spectrum location. However, if it happens that on the date a provision of the RFSAP comes into effect, there is a conflict between the RFSAP and the latest versions of the National Radio Frequency Plan (NRFP) and Terrestrial Broadcasting Frequency Plan, the NRFP and the Terrestrial Broadcasting Frequency Plan will prevail.



Dr SS MNCUBE
CHAIRPERSON



Final Radio Frequency Spectrum Assignment Plan

**Rules for Services operating in the
Frequency Band
450 to 470 MHz
(IMT450)**

Table of Contents

| | | |
|----|----------------------------------------------------------|----|
| 1 | Glossary | 5 |
| 2 | Purpose | 6 |
| 3 | General | 6 |
| 4 | Channelling Plan | 8 |
| 5 | Requirements for usage of radio frequency spectrum | 10 |
| 6 | Implementation | 10 |
| 7 | Coordination Requirements | 10 |
| 8 | Assignment | 12 |
| 9 | Amendment | 12 |
| 10 | Radio Frequency Migration | 12 |
| | Appendix A National Radio Frequency Plan | 15 |
| | Appendix B Propagation Model | 17 |
| | Appendix C Coordination for IMT-Systems | 19 |
| | Appendix D Interference Resolution Process | 24 |

1 Glossary

In this Radio Frequency Spectrum Assignment Plan, terms used will have the same meaning as in the Electronic Communications Act 2005 (no. 36 of 2005); unless the context indicates otherwise:

| | |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| “3GPP” | means the 3rd Generation Partnership Project (3GPP) which consists of six telecommunications standard development organisations |
| “Act” | means the Electronic Communications Act, 2005 (Act No. 36 of 2005) as amended |
| “DM RS” | means Demodulation Reference Signal |
| “ECC/REC(11)04” | means ECC Recommendation (11)04 |
| “ECC” | means Electronic Communications Committee within the European Conference of Postal and Telecommunications Administrations (CEPT) |
| “FDD” | means Frequency Division Duplex |
| “HCM” | means Harmonised Calculation Method |
| “ICNIRP” | Means International Commission on Non-Ionizing Radiation Protection (ICNIRP) |
| “IMT” | means International Mobile Telecommunications |
| “IMT450” | means IMT in the 450MHz band |
| “ITA” | means Invitation to Apply |
| “ITU” | means the International Telecommunication Union |
| “ITU-R” | means the International Telecommunication Union Radiocommunication Sector |
| “LTE” | means Long Term Evolution is a standard for wireless communication of high-speed data for mobile phones and data terminals. It is based on the GSM/EDGE and UMTS/HSPA network technologies |
| “NRFP” | means the National Radio Frequency Plan 2013 for South Africa |
| “PCI” | means Physical-Layer Cell Identities |
| “PPDR” | means Public Protection and Disaster Relief as defined in ITU-R Report M.2033. |
| “PRACH” | means Physical Random Access Channel |
| “PSTN” | means Public Switched Telephone Network |
| “PUCCH” | means Physical Uplink Control Channel |

| | |
|-----------------|--------------------------------------------------------------------------------|
| “RFSAP” | means Radio Frequency Spectrum Assignment Plan |
| “TCA” | means Terrain Clearance Angle |
| “TDD” | means Time Division Duplex |
| “WRC-12” | means World Radiocommunication Conference 2012 held in Geneva |
| “WRC-15” | means World Radiocommunication Conference planned to be held in 2015 in Geneva |

2 Purpose

- 2.1 A Radio Frequency Spectrum Assignment Plan (RFSAP) provides information on the requirements attached to the use of a frequency band in line with the allocation and other information in the National Radio Frequency Plan (NRFP). This information includes technical characteristics of radio systems, frequency channelling, coordination and details on required migration of existing users of the band and the expected method of assignment.
- 2.2 This Frequency Assignment Plan states the requirements for the utilisation of the frequency band between 450 MHz and 470 MHz for IMT450 in South Africa.
- 2.3 The ITU states that International Mobile Telecommunications (IMT) systems are mobile systems that provide access to a wide range of telecommunication services including advanced mobile services, supported by mobile and fixed networks, which are increasingly packet-based.

Key features are:

- a high degree of commonality of functionality worldwide whilst retaining the flexibility to support a wide range of services and applications in a cost efficient manner;
- compatibility of services within IMT and with fixed networks;
- capability of interworking with other radio access systems;
- high quality mobile services;
- user equipment suitable for worldwide use;
- user-friendly applications, services and equipment;
- worldwide roaming capability; and
- enhanced peak data rates to support advanced services and applications

3 General

- 3.1 Technical characteristics of equipment used in IMT450 systems must conform to all applicable South African standards, international standards, International

Telecommunications Union (ITU) and its radio regulations as agreed and adopted by South Africa.

- 3.2 All installations must comply with safety rules as specified in applicable standards.
- 3.3 The equipment used must be certified under South African law and regulations.
- 3.4 The allocation of this frequency band and the information in this Radio Frequency Spectrum Assignment Plan (RFSAP) are subject to review.
- 3.5 Frequency bands assigned for IMT450 include bands 450 – 470MHz.
- 3.6 Likely use of this band will be for rural mobile broadband, PPDR or M2M communications nationwide.
- 3.7 The technologies which can provide IMT450 services include, but are not limited to:
 - LTE;
 - LTE Advanced;
 - HSPA+; and
 - WiMAX.
- 3.8 Typical technical and operational characteristics of IMT systems, as identified by the ITU, are described in the following documents:
 - Recommendation ITU-R M.2012-1 (02/2014): Detailed specifications of the terrestrial radio interfaces of International Mobile Telecommunications-Advanced (IMT Advanced);
 - Report ITU-R M.2110: Sharing studies between Radiocommunication services and IMT systems operating in the 450-470 MHz band;
 - Recommendation ITU-R M.1645 Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-2000; and
 - Recommendation ITU-R M.1036-4: Frequency arrangements for implementation of the terrestrial component of International Mobile Telecommunications (IMT) in the bands identified for IMT in the Radio Regulations (RR).

4 Channelling Plan

4.1 The frequency band 450 – 470 MHz provides a total bandwidth of 2×5MHz FDD or 15MHz TDD for IMT450.

4.2 Channel arrangements.

4.3 The channel arrangements under consideration are based on the Recommendation ITU-R M.1036-4.

| Frequency arrangements | Paired arrangements | | | | Unpaired arrangements (e.g. for TDD) (MHz) |
|------------------------|----------------------------------|------------------|--------------------------------|-------------------------|--------------------------------------------|
| | Mobile station transmitter (MHz) | Centre gap (MHz) | Base station transmitter (MHz) | Duplex separation (MHz) | |
| D1 | 450.000-454.800 | 5.2 | 460.000-464.800 | 10 | None |
| D2 | 451.325-455.725 | 5.6 | 461.325-465.725 | 10 | None |
| D3 | 452.000-456.475 | 5.525 | 462.000-466.475 | 10 | None |
| D4 | 452.500-457.475 | 5.025 | 462.500-467.475 | 10 | None |
| D5 | 453.000-457.500 | 5.5 | 463.000-467.500 | 10 | None |
| D6 | 455.250-459.975 | 5.275 | 465.250-469.975 | 10 | None |
| D7 | 450.000-457.500 | 5.0 | 462.500-470.000 | 12.5 | None |
| D8 | | | | | 450-470 TDD |
| D9 | 450.000-455.000 | 10.0 | 465.000-470.000 | 15 | 457.500-462.500 TDD |
| D10 | 451.000-458.000 | 3.0 | 461.000-468.000 | 10 | None |

Table 1: Channel arrangements for IMT450 (Source: ITU)

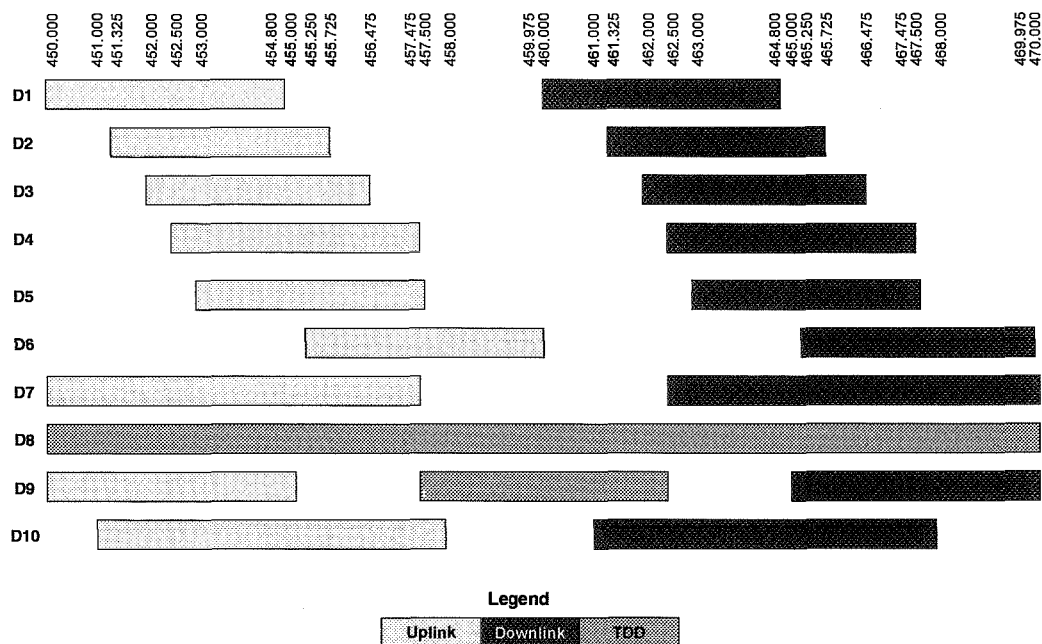


Figure 1: Channel arrangements for IMT450 (Source ITU)

For South Africa, the channel arrangements will be one of either D2, D3, D4 or D5. These options are applicable due to the need to maintain a guardband of 2.5 MHz to broadcast channel 21 and 1 MHz guardband to narrowband systems.

The channel arrangements as applicable to South Africa are depicted below, including the potential assignment to Transnet in cases of co-existence.

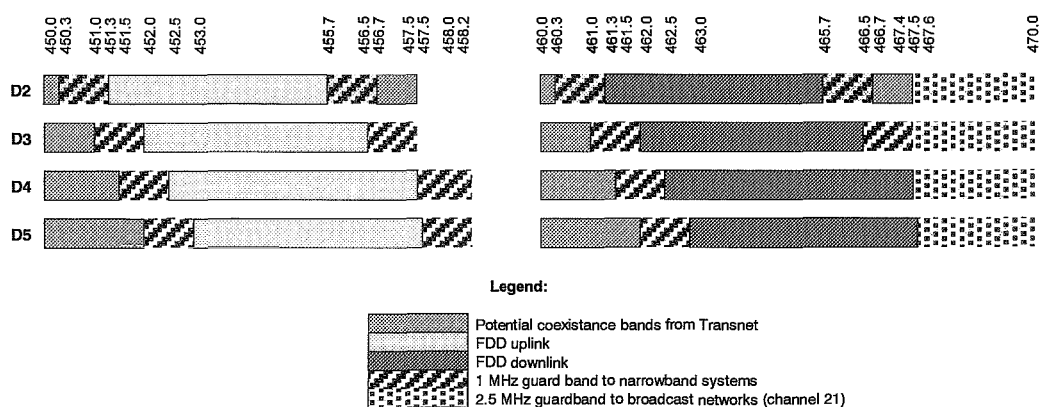


Figure 2: Channel options for South Africa

5 Requirements for usage of radio frequency spectrum

- 5.1 This chapter covers the minimum key characteristics considered necessary in order to make the best use of the available frequencies.
- 5.2 The use of the band is limited for IMT-services; narrowband services capable of coexistence with IMT may also be permitted. PPDR-supporting or M2M services might be implemented via IMT.
- 5.3 Only systems using digital technologies that promote spectral efficiency will be issued with an assignment. Capacity-enhancing, digital techniques are being rapidly developed and such techniques that promote efficient use of spectrum, without reducing quality of service are encouraged.
- 5.4 In some cases, a radio system conforming to the requirements of this RFSAP may require modifications if harmful interference is caused to other radio stations or systems.
- 5.5 The allocation of spectrum and shared services within these bands are found in the National Radio Frequency Plan (NRFP) and an extract of NRFP is shown in Appendix A.
- 5.6 Maximum radiated power:
 - 5.6.1 Base Station transmissions should not exceed 61dBm/5MHz EIRP;
 - 5.6.2 Mobile Station transmissions should not exceed 23dBm EIRP;
 - 5.6.3 On a case-by-case basis, higher EIRP may be permitted if acceptable technical justification is provided;
 - 5.6.4 Where appropriate, subscriber terminal stations should comply with the technical specification outlined under “3GPP TS 36.521-1” or the latest version.
- 5.7 ICNIRP compliance is encouraged, where applicable.
- 5.8 Criteria and guidelines for interference mitigation are described in Appendix D.

6 Implementation

- 6.1 This Radio Frequency Assignment Plan comes into effect on the 1st April 2018 except for the provisions in paragraph 6.2. which apply from the date of publication.
- 6.2 No new assignments in the band 450 – 470MHz will be approved unless they comply with this RFSAP.

7 Coordination Requirements

- 7.1 Use of these frequency bands will require coordination with the neighbouring countries within the coordination zones, of 6 kilometres in cases of LTE-to-LTE or 9 kilometres in cases of LTE-to-other technologies from the neighbouring country.

The coordination distances are continuously being reviewed and these may be updated from time to time.

- 7.2** The following field strength thresholds have to be assured based on (ECC/REC(11)04 for 790-862MHz. Operator-to-operator coordination may be necessary to avoid interference.

In general, stations of FDD systems may be used without coordination with a neighbouring country if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 55dB μ V/m/5MHz at a height of 3 m above ground at the borders between countries and does not exceed a value of 29dB μ V/m/5MHz at a height of 3 m above ground at a distance of 9 km inside the neighbouring country.

In the case that LTE is deployed both sides of the border, the field strength levels can be increased to 59 dB μ V/m/5MHz and 41 dB μ V/m/5MHz at 6 km.

If TDD is in operation across both sides of a border and is synchronised across the border then field strength levels as well.

For field strength predictions the calculations should be made according to Appendix B. In cases of other frequency block sizes 10*log (frequency block size/5MHz) should be added to the field strength values e.g.:

| BW (MHz) | Field strength level at 3 m height (general case) | Field strength level at 3 m height (LTE case) |
|----------|---------------------------------------------------|-----------------------------------------------|
| 5 MHz | 55.0 dB μ V/m/5MHz @0km | 59.0 dB μ V/m/5MHz @0km |
| | 29.0 dB μ V/m/5MHz @9km | 41.0 dB μ V/m/5MHz @6km |
| 10 MHz | 58.0 dB μ V/m/10MHz @0km | 62.0 dB μ V/m/10MHz @0km |
| | 32.0 dB μ V/m/10MHz @9km | 44.0 dB μ V/m/10MHz @6km |
| 15 MHz | 59.8 dB μ V/m/15MHz @0km | 63.8 dB μ V/m/15MHz @0km |
| | 33.8 dB μ V/m/15MHz @9km | 45.8 dB μ V/m/15MHz @6km |
| 20 MHz | 61.0 dB μ V/m/20MHz @0km | 65.0 dB μ V/m/20MHz @0km |
| | 35.0 dB μ V/m/20MHz @9km | 47.0 dB μ V/m/20MHz @6km |

If neighbouring administrations wish to agree on frequency coordination based on preferential frequencies, whilst ensuring equitable treatment of different operators within a country, the Authority will add these into the mutual agreements.

Stations of IMT systems may be operated without coordination if the mean field strength produced by the cell (all transmitters within the sector) does not exceed the value of 15dB μ V/m/5 MHz at 10% time, 50% of locations at 3 metres above ground level at the border line.

- 7.3 Technical analysis may be conducted by the Authority before an assignment is issued according to Appendix B based on an extract from ECC/REC (11)05.
- 7.4 Specific information regarding coordination may be found in Appendix C, an extract from ECC/REC (11)05.
- 7.5 In the event of any interference, the Authority will require affected parties to carry out coordination. In the event that the interference continues to be unresolved after 24 hours, the affected parties may refer the matter to the Authority for a resolution. The Authority will decide upon the necessary modifications and schedule of modifications to resolve the dispute. The Authority will be guided by the interference resolution process as shown in Appendix D.
- 7.6 Assignment holders must take full advantage of interference mitigation techniques such as antenna discrimination, tilt, polarisation, frequency discrimination, shielding/blocking (introduce diffraction loss), site selection, and/or power control to facilitate the coordination of systems.

8 Assignment

- 8.1 An Invitation to Apply will be published for new assignments in this band in line with regulations developed in terms of section 31(3) of the Act.

9 Amendment

- 9.1 All radio frequency spectrum licences are amended except for cases where their coexistence with IMT is proven.
- 9.1.1 Existing radio frequency spectrum licences for the use of the band will be amended as of 31st March 2018 for licensees operating in rural areas (except Transnet).
- 9.1.2 Existing radio frequency spectrum licences for the use of the band will be amended as of 31st March 2022 for all remaining licensees.
- 9.2 In cases of coexistence, i.e., where a radio frequency spectrum licensee is able to migrate within the 450-470 MHz band and coexist with IMT, the radio frequency spectrum licence will be modified accordingly.

10 Radio Frequency Migration

- 10.1 Potential destination bands.

The following graph describes the migration necessary to allocate the 450-470 MHz for IMT use:

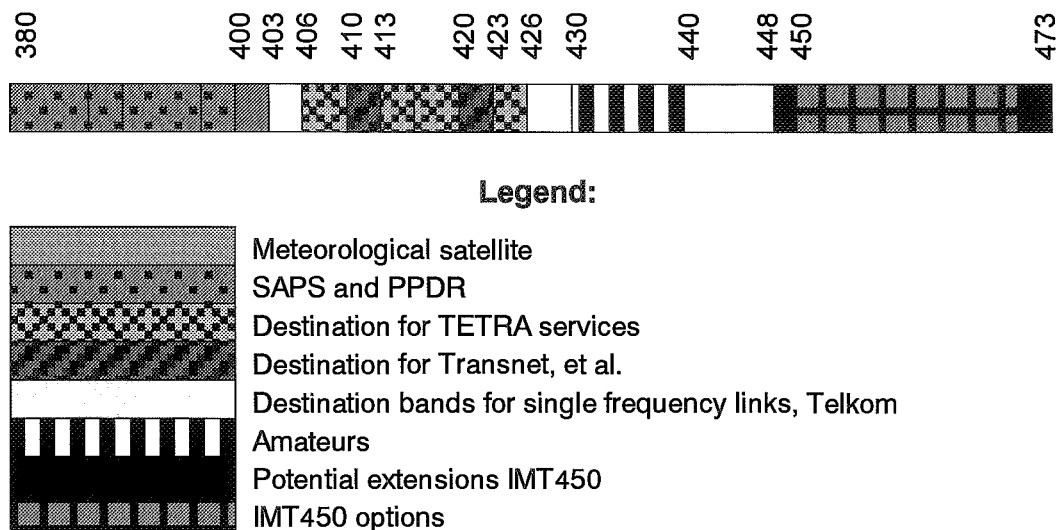


Figure 3: 450-470MHz potential destination spectrum

10.2 Migration Process:

- Migration starts in 2016 and is completed in 2022;
- Dual illumination stops in 2022;
- **SAPS** - free up 406-426 MHz and migrate to 380-400 MHz:
 - Additional 2x3 MHz are still free for potential PPDR licences, e.g., for emergencies, airports (SAA).
- **Transnet** - free up 450-470 MHz and potentially migrate to 406-426 MHz:
 - From 2016 Transnet can commence migration to 410-413//420-423MHz (2x3 MHz);
 - *Alternatively there are 2x4 MHz and 2x3 MHz for TETRA available in 406-426 MHz;*
 - Transnet may also migrate to GSM R.
- **Other licensees** - migrate from 450-470 MHz to:
 - 403-406 MHz (unpaired);
 - 426-430 MHz (unpaired);
 - 440-450 MHz (paired or unpaired), potentially for municipality networks; and
 - In cases of PPDR-use also to 387-390//397-400 MHz.
- **430-440 MHz** (amateurs) may be used in cases of congestion for a defined period e.g. two years.
- Many municipality networks are in the 440-450 MHz bands. Depending on future demand, a harmonisation might take place.

- In Figure 3, potential extensions to the IMT450-band are marked as well, in order to mitigate potential interference with the direct neighbour bands. These might be reserved in the case of extending 2×5 MHz to 2×10MHz, or to minimise interference.

10.3 Specific Procedure:

Existing licensees must migrate according to the specified process.

Appendix A National Radio Frequency Plan

| ITU Region 1 allocation and footnotes | South African Allocation and footnotes | Typical Applications | Comments |
|---------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| 450-455 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286, 5.286A 5.286B 5.286C 5.286D 5.286E | 400-455 MHz FIXED MOBILE 5.286AA NF9 5.209 5.286 5.286A | Fixed links (450-453 MHz) Single Frequency Mobile (453-454 MHz) Paging (454-454.425MHz) Trunked Mobile BTX (454.425-460 MHz) IMT 450(450-470 MHz) | Paired with 460-463 MHz Government Services Paired with 464.425-470 MHz |
| 455-456 MHz FIXED MOBILE 5.286AA 5.209 5.271 5.286A 5.286B 5.286C 5.286E | 455-456 MHz FIXED MOBILE 5.286AA NF9 5.209 5.286A | Trunked Mobile BTX (454.425-460MHz) IMT 450(450-470 MHz) Government Services | Paired with 464.425-470 MHz |
| 456-459 MHz FIXED MOBILE 5.286AA 5.271 5.287 5.288 | 456-459 MHz FIXED MOBILE 5.286AA NF9 5.287 | Trunked Mobile BTX (454.425-460MHz) IMT 450(450-470 MHz) Government Services | Paired with 464.425-470 MHz |
| 459-460 MHz FIXED MOBILE 5.286AA | 459-460 MHz FIXED MOBILE 5.286AA NF9 | Trunked Mobile BTX (454.425 - 460 MHz) IMT 450(450-470 MHz) Government Services | Paired with 464.425-470 MHz |

| | | | |
|----------------------------------------------------------------------|-----------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5.209 5.271 5.286A 5.286B 5.286C 5.286E | 5.209 5.271 5.286A | | |
| 460-470 MHz FIXED MOBILE 5.286AA | 460-470 MHz FIXED MOBILE 5.286AA NF9 | Fixed links (460-463 MHz) Single Frequency Mobile (463.025-463.975 MHz) Low Power Mobile Radio(463.975 MHz, 464.125 MHz, 464.175 MHz, 464.325 MHz, 464.375 MHz) Single Frequency Mobile (464.375-464.425 MHz) Trunked Mobile MTX (464-470 MHz) IMT 450(450-470 MHz) Security Systems (464.5375 MHz) Non specific SRDs (464.5-464.5875 MHz) Government Services | Paired with 450-453 MHz Radio Frequency Spectrum Regulations Annex B GG No 34172, 31 March 2011) Paired with 454.425-460 MHz Radio Frequency Spectrum Regulations (Annex B (GG. No 34172, 31 March 2011) |
| Meteorological satellite (space to Earth) 5.287, 5.288, 5.289, 5.290 | 5.287, 5.289 | | |

Appendix B Propagation Model

The following methods are proposed for assessment of anticipated interference inside neighbouring countries based on established trigger values. Due to the complexity of radio-wave propagation nature, different methods are proposed to be considered by administrations and are included here for guidance purposes only. It should be noted that the following methods provide theoretical predictions based on available terrain knowledge. It is practically impossible to recreate these methods with measurement procedures in the field. Therefore, only some approximation of measurements could be used to check compliance with those methods based on practical measurement procedures. The details of such approximation are not included in this recommendation and should be negotiated between countries based on their radio monitoring practices.

Path specific model

Where appropriate detailed terrain data is available, the propagation model for interference field strength prediction is the latest version of ITU-R Rec. P.452, For the relevant transmitting terminal, predictions of path loss would be made at x km steps along radials of y km at z degree intervals¹. The values for those receiver locations within the neighbouring country would be used to construct a histogram of path loss – and if more than 10% of predicted values exceed the threshold the station should be required to be coordinated.

Site general model

If it is not desirable to utilise detailed terrain height data for the propagation modelling in the border area, the basic model to be used to trigger coordination between administrations and to decide if coordination is necessary, is ITU-R Rec. P.1546, “Method for point to area predictions for terrestrial services in the frequency range 30 to 3000 MHz”. This model is to be employed for 50% of locations, 10% time and using a receiver height of 3 m. For specific reception areas where terrain roughness adjustments for improved accuracy of field strength prediction are needed, administrations may use correction factors according to terrain irregularity and/or an averaged value of the TCA parameter in order to describe the roughness of the area on and around the coordination line.

Administrations and/or operators concerned may agree to deviate from the aforementioned model by mutual consent.

¹ . Values for x, y, z and path specific field strength levels are to be agreed between the administrations concerned

Area calculations

In the case where greater accuracy is required, administrations and operators may use the area calculation below. For calculations, all the pixels of a given geographical area to be agreed between the Administrations concerned in a neighbouring country are to be taken into consideration. For the relevant base station, predictions of path loss should be made for all the pixels of a given geographical area from a base station and at a receiver antenna height of 3 m above ground.

For evaluation:

- only 10% of the number of geographical areas between the border line (including the border line) and the 6 km line itself inside the neighbouring country may be interfered with by higher field strength than the trigger field strength value given for the border line in section 7.2 at a height of 3m above ground.
- only 10% of the number of geographical areas between the 6km (including the 6km line) and 12km line inside the neighbouring country may be interfered with by a higher field strength than the trigger field strength value given for the 6km line in section 7.2 at a height of 3m above ground.

It is recommended that during area calculations, not only detailed terrain data but also clutter data be taken into account. Use of correction factors for clutter is crucial in particular where the border area is 'open' or 'quasi-open' from the point of view of clutter or where the interfering base station is just a few kilometres from a border line.

If the distance between a base station and a terrain point of a border line is closer than or equal to 1km, free space propagation model needs to be applied. Furthermore, if there is no terrain obstacle within the 1st Fresnel zone, the free space propagation model should be applied.

If clutter data is not available, it is proposed to extend the usage of the free space propagation model to a few kilometres, depending on the clutter situation in border areas.

For area type interference calculations, propagation models with path-specific terrain correction factors are recommended (e.g. Recommendation ITU-R P.1546 with the Terrain Clearance Angle correction factor TCA, HCM method with the Terrain Clearance Angle correction factor or Recommendation ITU-R P.1812).

As to correction factors for clutters 'open area' and 'quasi-open area', 20 dB and 15 dB should be used respectively. Recommendation ITU-R P.1406 should be used if a finer selection of clutter is required.

It must be noted that terrain irregularity factor Δh is not recommended to be used in area calculations. Administrations and/or operators concerned may agree to deviate from the aforementioned models by mutual consent.

Appendix C Coordination for IMT-Systems

PREFERENTIAL PHYSICAL-LAYER CELL IDENTITIES (PCI) FOR IMT-2000/LTE²

The following is extracted from ECC/REC(11)05 as an operational example and can be adapted for the SADC-countries

PCI coordination is only needed when channel centre frequencies are aligned independent of the channel bandwidth.

3GPP TS 36.211 defines 168 “unique physical-layer cell-identity groups” in §6.11, numbered 0...167, hereafter called “PCI groups”. Within each PCI group there are three separate PCIs giving 504 PCIs in total.

Administrations should agree on a repartition of these 504 PCI on an equitable basis when channel centre frequencies are aligned as shown in the table below. It has to be noted that dividing the PCI groups or PCI's is equivalent. Each country can use all PCI groups away from the border areas.

As shown in the table below, the PCIs should be divided into 6 sub-sets containing each one sixth of the available PCIs. Each country is allocated three sets (half of the PCIs) in a bilateral case, and two sets (one third of the PCIs) in a trilateral case.

Four types of countries are defined in a way such that no country will use the same code set as any one of its neighbours. The following lists describe the distribution of European countries (*which needs to be adapted for SADC*):

Type country 1: BEL, CVA, CYP, CZE, DNK, E, FIN, GRC, IRL, ISL, LTU, MCO, SMR, SUI, SVN, UKR, AZE, SRB;

Type country 2: AND, BIH, BLR, BUL, D, EST, G, HNG, I, MDA, RUS (Exclave), GEO;

Type country 3: ALB, AUT, F, HOL, HRV, POL, POR, ROU, RUS, S, MLT;

Type country 4: LIE, LUX, LVA, MKD, MNE, NOR, SVK, TUR.

For each type of country, the following tables and figure describe the sharing of the PCIs with its neighbouring countries, with the following conventions of writing:

| | |
|--|----------------------|
| | Preferential PCI |
| | Non-preferential PCI |

² ECC/REC(11)05

The 504 physical-layer cell-identities should be divided into the following 6 sub-sets when the carrier frequencies are aligned in border areas:

| PCI | Set A | Set B | Set C | Set D | Set E | Set F | PCI | Set A | Set B | Set C | Set D | Set E | Set F |
|------------------|-------|---------|----------|----------|----------|----------|------------------|-------|---------|----------|----------|----------|----------|
| Country 1 | 0..83 | 84..167 | 168..251 | 252..335 | 336..419 | 420..503 | Country 2 | 0..83 | 84..167 | 168..251 | 252..335 | 336..419 | 420..503 |
| Border 1-2 | | | | | | | Border 2-1 | | | | | | |
| Zone 1-2-3 | | | | | | | Zone 2-3-1 | | | | | | |
| Border 1-3 | | | | | | | Border 2-3 | | | | | | |
| Zone 1-2-4 | | | | | | | Zone 2-1-4 | | | | | | |
| Border 1-4 | | | | | | | Border 2-4 | | | | | | |
| Zone 1-3-4 | | | | | | | Zone 2-3-4 | | | | | | |

| PCI | Set A | Set B | Set C | Set D | Set E | Set F | PCI | Set A | Set B | Set C | Set D | Set E | Set F |
|------------------|-------|---------|----------|----------|----------|----------|------------------|-------|---------|----------|----------|----------|----------|
| Country 3 | 0..83 | 84..167 | 168..251 | 252..335 | 336..419 | 420..503 | Country 4 | 0..83 | 84..167 | 168..251 | 252..335 | 336..419 | 420..503 |
| Border 3-2 | | | | | | | Border 4-1 | | | | | | |
| Zone 3-1-2 | | | | | | | Zone 4-1-2 | | | | | | |
| Border 3-1 | | | | | | | Border 4-2 | | | | | | |
| Zone 3-1-4 | | | | | | | Zone 4-2-3 | | | | | | |
| Border 3-4 | | | | | | | Border 4-3 | | | | | | |
| Zone 3-2-4 | | | | | | | Zone 4-3-1 | | | | | | |

Notes

- 1) All PCIs are available in areas away from the border.
- 2) In certain specific cases (e.g. AUT/HRV), where the distance between two countries of the same type number is very small, it may be necessary to address the situation in bi/multilateral coordination agreements as necessary, and may include further subdivision of the allocated codes in certain areas.

GUIDANCE ON THE CONSIDERATION OF LTE RADIO PARAMETERS FOR USE IN BILATERAL AND MULTI LATERAL AGREEMENTS

This section is provided for guidance purposes, for use in bilateral and multilateral discussions. For LTE, it may be beneficial to coordinate other radio parameters besides PCI in order to minimise deteriorating effects of uplink interference.

The parameters described in this section are usually optimised during LTE radio network planning of an operator's network. The idea of optimisation is to plan the parameters, taking into account specific correlation properties of the uplink control signals which enable more stable and predictable operation of the network. In the cross-border scenario, the optimisation of parameters among neighbouring operators could provide better control of uplink interference. However, because of the difference between intra-network and inter-network interference and due to limited experience in the LTE cross-border deployment, it is difficult to assess the benefits of such optimisation. The following guidance provides the basis for operators to consider in border areas in cases of high levels of uplink interference.

1. Demodulation Reference Signal (DM RS) coordination

Demodulation reference signals (DM RS) are transmitted in the uplink and used for channel estimation. There is a risk of inter cell interference between neighbouring cells even in cases of no-frame synchronisation. That is why special measures for DM RS allocation between networks in neighbouring countries occupying the same channel may need to be applied.

The case of partial channel overlap has not been studied but, due to DM RS occupying resource blocks of separate users, there is a risk of DM RS collisions between neighbouring networks when the subcarriers' positions coincide (the frequency offset between central carriers of neighbouring networks is multiple of 300 kHz). Some minor benefits from DM RS coordination in these particular cases could be expected.

There are a number of possible approaches to the coordination of DM RS:

- In basic planning procedure only 30 DM RS sequence groups with favourable correlation characteristics are available: {0...29}. In this case each cell could be assigned one of the 30 DM RS sequence groups providing a cluster size of 30.
- It is possible to extend each DM RS sequence group to generate up to 12 time-shifted sequence groups by applying the cyclic shift parameter stated in 3GPP TS 36.211. For example, each tri-sector site could be assigned one DM RS sequence group with each co-sited cell having its own cyclic shift of $2\pi/3$ which provides cluster size 30 only with 10 DM RS sequence groups. The latter case corresponds well to the case of DM RS sequence groups repartition between neighbouring countries when only a limited number of groups are available for network planning. The drawback of DM RS sequence group cyclic shift is a loss of orthogonality of DM RS due to fading channels which has been found only recently during first trials of LTE and caused throughput loss as well as time alignment problems.

- Another approach for DM RS coordination is to implement dynamic DM RS sequence group allocation also called pseudo-random group hopping. In this method, nearby cells are grouped into clusters of up to 30 cells and within each cell cluster the same hopping pattern is used. At the border of two clusters, inter-cell interference is averaged since two different hopping patterns are used. There are 17 defined hopping patterns, numbered {0...16}, which leads to some minor inequality in the case of apportioning these patterns between neighbouring countries. Even in a trilateral case, each operator will have at least 5 hopping patterns available near the border which should be enough for planning purposes. It should be noted the pseudo-random group hopping option could be absent in the first generations of LTE equipment.

The decision of which of these methods to use in cross-border coordination should be agreed upon by the interested parties. Specific DM RS sequence groups or hopping patterns repartition is not provided in the text of this Recommendation but could be deduced in a similar manner to the PCI repartition.

2. Physical Random Access Channel (PRACH) coordination

Another radio network parameter which is considered during radio network planning is PRACH configuration which is needed to distinguish random access requests addressed to different cells. PRACH resources are allocated by specifying the PRACH Resource Blocks time positions within the uplink frame, their frequency position within the LTE channel bandwidth and by apportioning cell-specific root sequences. During radio network planning these parameters are usually used in the following way:

- time positions for PRACH resource allocations are usually used to create time collision of PRACH resources of co-sited/frame synchronised cells because PRACH-to-PRACH interference is usually less severe than PUSCH-to-PRACH interference;
- frequency positions within the LTE channel bandwidth is usually the same for all cells, again because the PRACH-to-PRACH interference case is the more favourable one; and
- cell-specific root sequences are used to distinguish between PRACH requests addressed to different cells.

For cross-border coordination, it is proposed to use frequency position offsets, to exclude the possibility of so-called “ghost” PRACH requests caused by neighbouring networks. The PRACH is configured in LTE to use only 6 Resource Blocks or 1.08 MHz of the LTE channel bandwidth except in regions used by PUCCH. In cases of overlapping or partially overlapping channel bandwidths of neighbouring networks, it is enough to establish non-overlapping PRACH frequency blocks to perform coordination. Because it is difficult to establish an implementation-dependent procedure for such allocation, it will be the responsibility of operators to manage such frequency separation during coordination discussions.

In early implementation, it is possible that a very limited number of frequency positions will be supported by LTE equipment which will not be enough to coordinate in the trilateral

case. In such cases, root-sequence repartition could be used. There are 838 root sequences in total, to be distributed between cells, numbered {0..837}. There are two numbering schemes for PRACH root sequences (physical and logical) and only logical root sequences numbering needs be used for coordination. Unfortunately, the process of root sequences planning doesn't involve direct mapping of root sequences between cells because the number of root sequences needed for one cell is dependent on the cell range. The table showing such interdependency is presented below:

| PRACH Configuration | Number of root seq. per cell | Cell Range (km) |
|---------------------|------------------------------|-----------------|
| 1 | 1 | 0.7 |
| 2 | 2 | 1 |
| 3 | 2 | 1.4 |
| 4 | 2 | 2 |
| 5 | 2 | 2.5 |
| 6 | 3 | 3.4 |
| 7 | 3 | 4.3 |
| 8 | 4 | 5.4 |
| 9 | 5 | 7.3 |
| 10 | 6 | 9.7 |
| 11 | 8 | 12.1 |
| 12 | 10 | 15.8 |
| 13 | 13 | 22.7 |
| 14 | 22 | 38.7 |
| 15 | 32 | 58.7 |
| 0 | 64 | 118.8 |

Thus, in the case of root sequence repartition, it will be the responsibility of radio network planners to assign the correct number of root sequences in order not to overlap with the root sequence ranges of other operators. It also should be noted that different root sequences have different cubic metrics and correlation properties which affect PRACH coverage performance and planning of so-called high-speed cells. For simplicity of cross-border coordination it is proposed to ignore these properties.

In summary, it should be stipulated that frequency separation of PRACH resources should be used as the main coordination method. PRACH root sequences repartition should be avoided and used only in exceptional cases. Specific PRACH root sequences repartition is not provided in the text of this Recommendation but could be deduced in a similar manner to the PCI repartition.

Appendix D Interference Resolution Process

When requesting coordination the relevant characteristics of the base station and the code or PCI group number should be forwarded to the Administration affected. All of the following characteristics should be included:

- a) carrier frequency [MHz];
- b) name of transmitter station;
- c) country of location of transmitter station;
- d) geographical coordinates [latitude, longitude];
- e) effective antenna height [m];
- f) antenna polarisation;
- g) antenna azimuth [deg];
- h) antenna gain [dBi];
- i) effective radiated power [dBW];
- j) expected coverage zone or radius [km];
- k) date of entry into service [month, year];
- l) code group number used; and
- m) antenna tilt [deg]

The Administration affected shall evaluate the request for coordination and shall within 30 days, notify the result of the evaluation to the Administration requesting coordination. If, in the course of the coordination procedure, the Administration affected requires additional information, it may request such information.

If no reply is received by the Administration requesting coordination within 30 days, it may send a reminder to the Administration affected. An Administration not having responded within 30 days following communication of the reminder shall be deemed to have given its consent, and the code coordination may be put into use with the characteristics given in the request for coordination.

The periods mentioned above may be extended by common consent.